Re-aggregating Domestic Demand

Factors and Trends in Municipal Water Use

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CWAC Technical Subcommittee
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Urban water usage rates, pre-recession

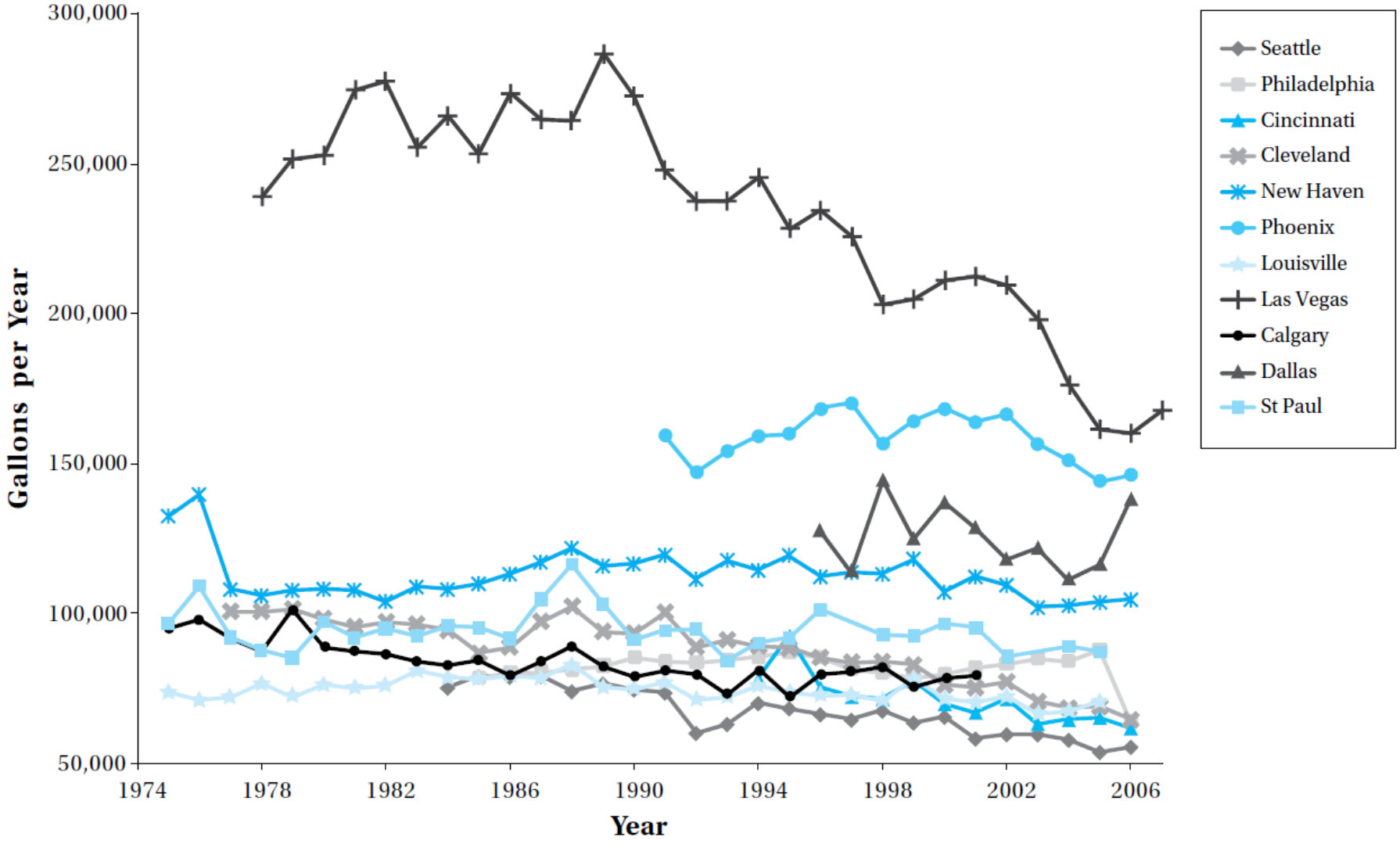
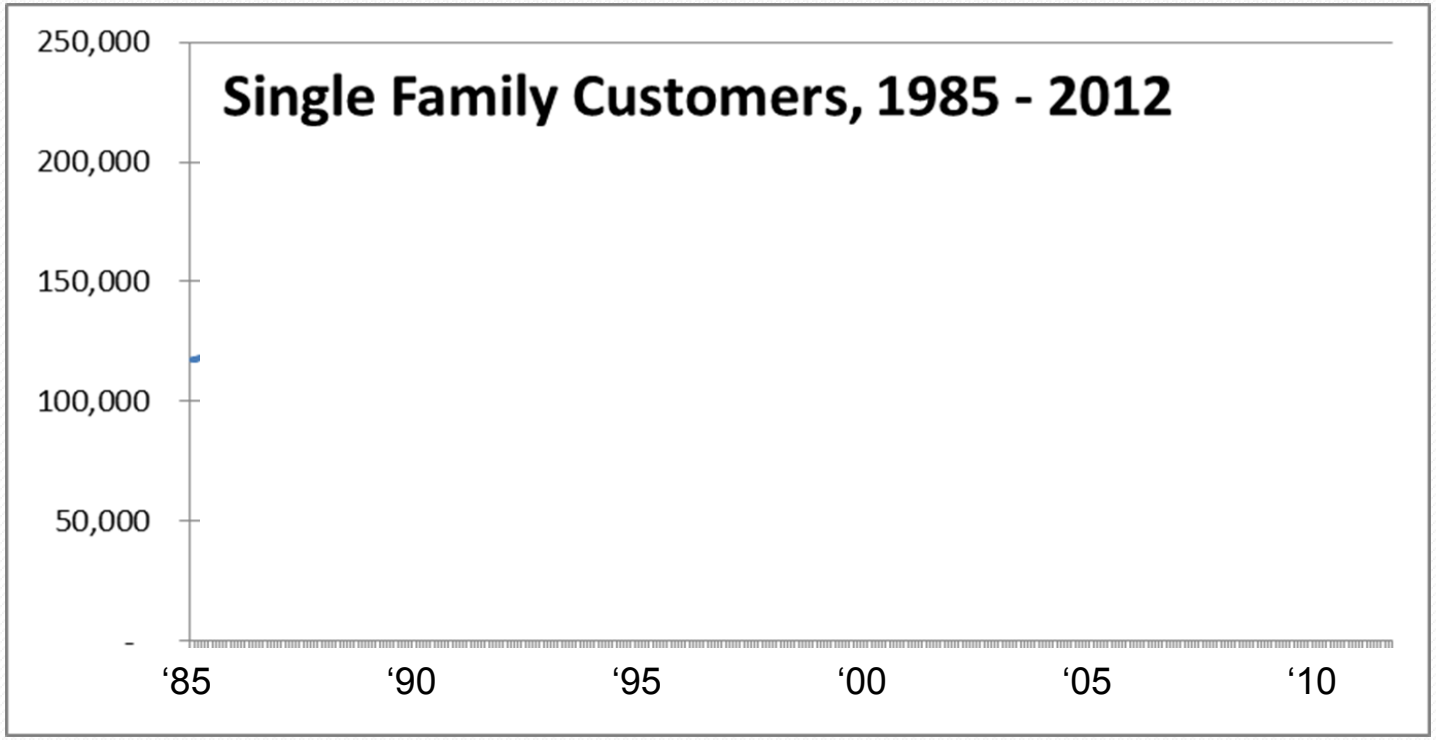


Figure 1. Annual water usage per residential customer, in gallons, for eleven major U.S. cities (Source: North America Residential Water Usage Trends Since 1992*)*

Long-term declines in per-capita water demand

Over the past 25+ years, municipal providers throughout the Southwest have experienced:

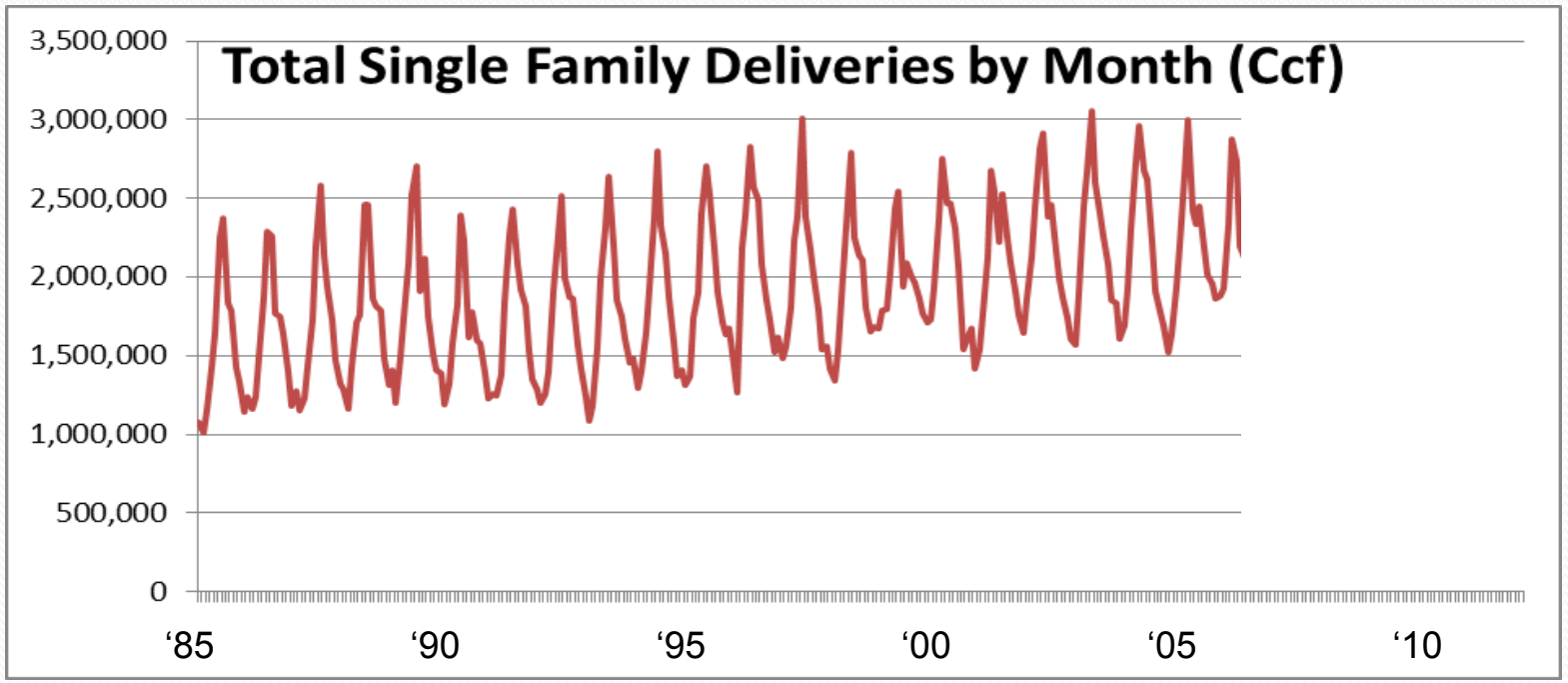
- Increasing service area populations
- Growing numbers of residential customers



Long-term declines in per-capita water demand

Over the past 25+ years, municipal providers throughout the Southwest have experienced:

- Increasing service area populations and
- Growing numbers of residential customers, but
- Essentially flat water deliveries



Long-term declines in per-capita water demand

Over the past 25+ years, municipal providers throughout the Southwest have experienced:

- Increasing service area populations
- Growing numbers of residential customers, but
- Essentially flat water deliveries

This was caused by:

- Declines in per-capita household demand
- Even greater declines in per-household demand

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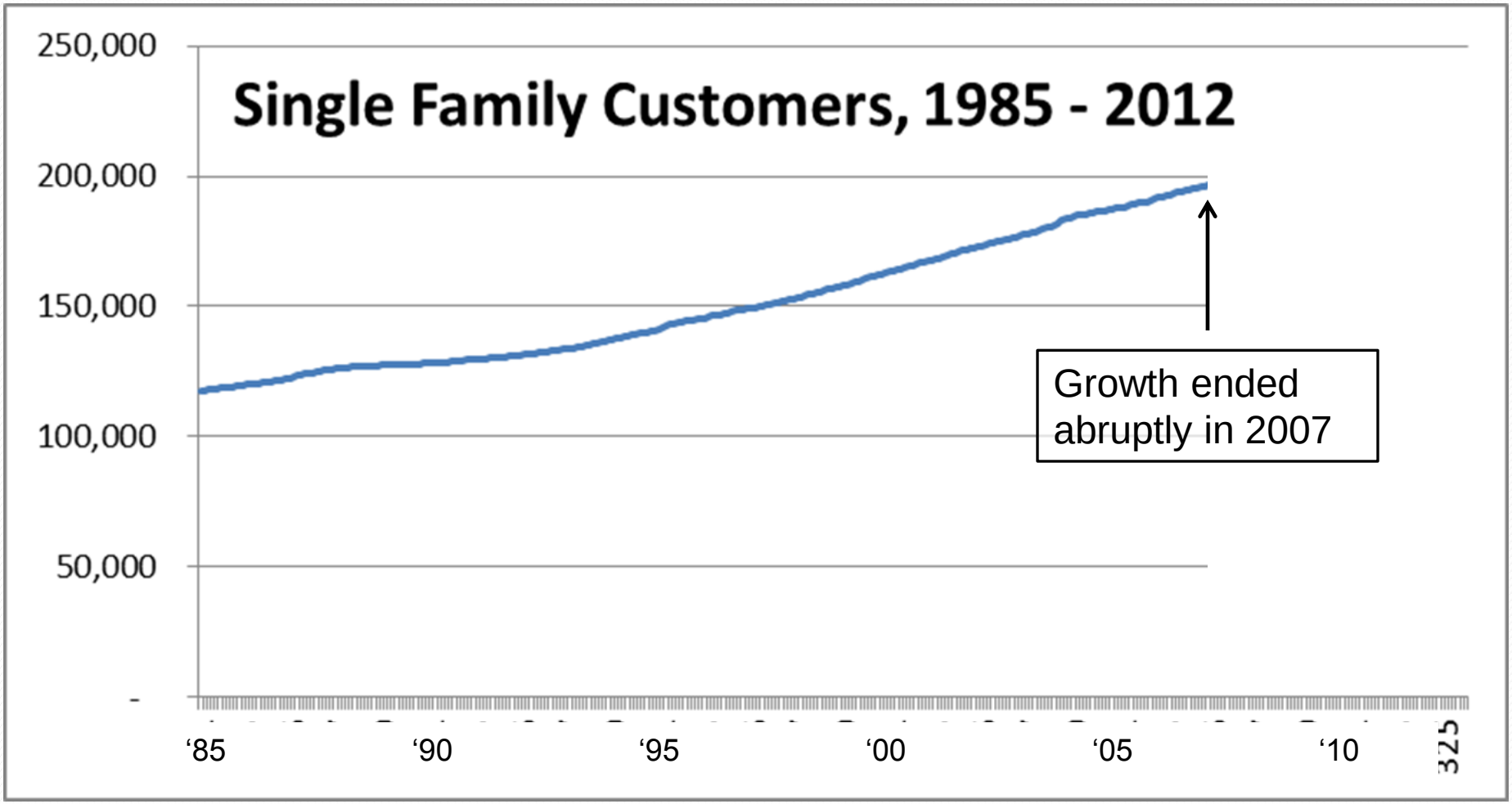
Housing collapse abruptly stopped new hookups



The housing bubble burst resulted in:

- plunging hook-up fees
- paying for unused system capacity
- vacant homes not using water
- delinquent water bill payments
- political resistance to rate hikes

Result was steeper declines in demand and substantial reductions in utility revenues.

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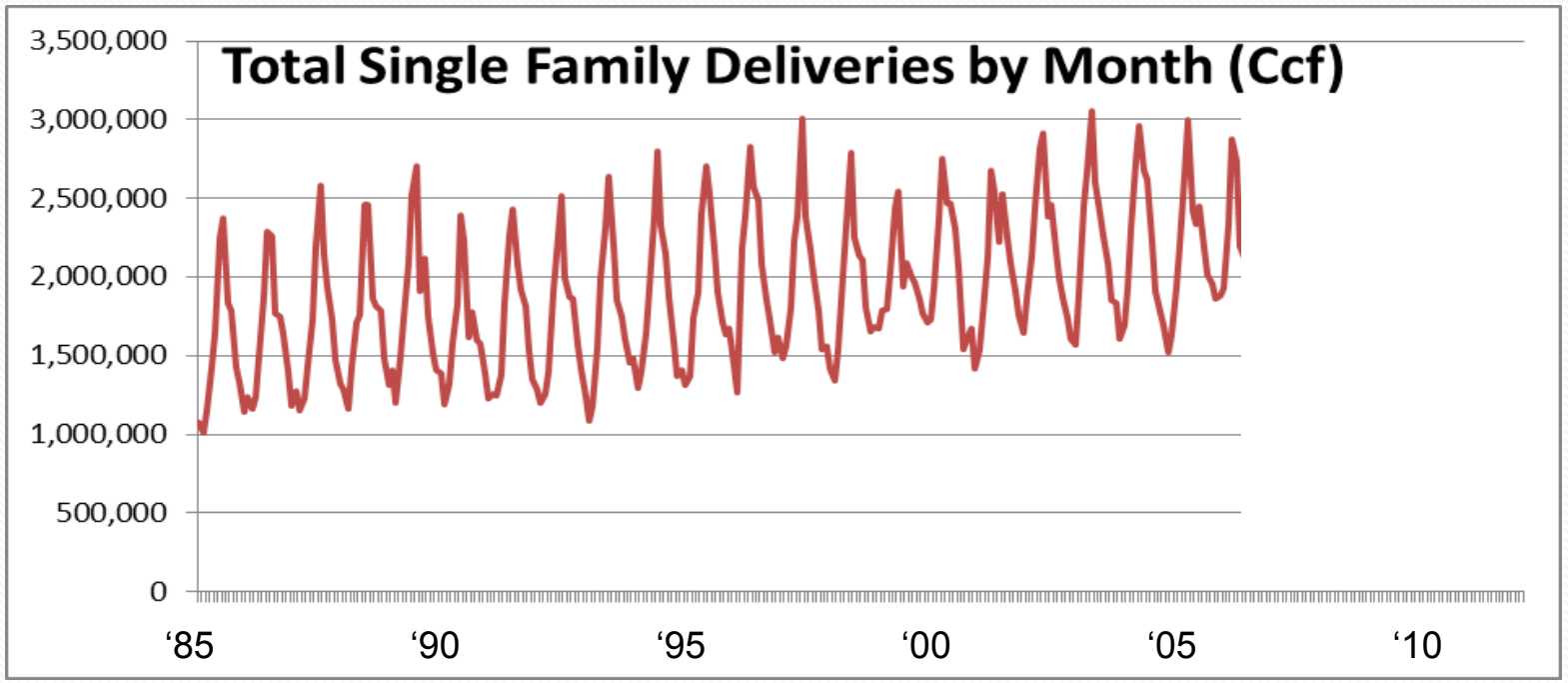
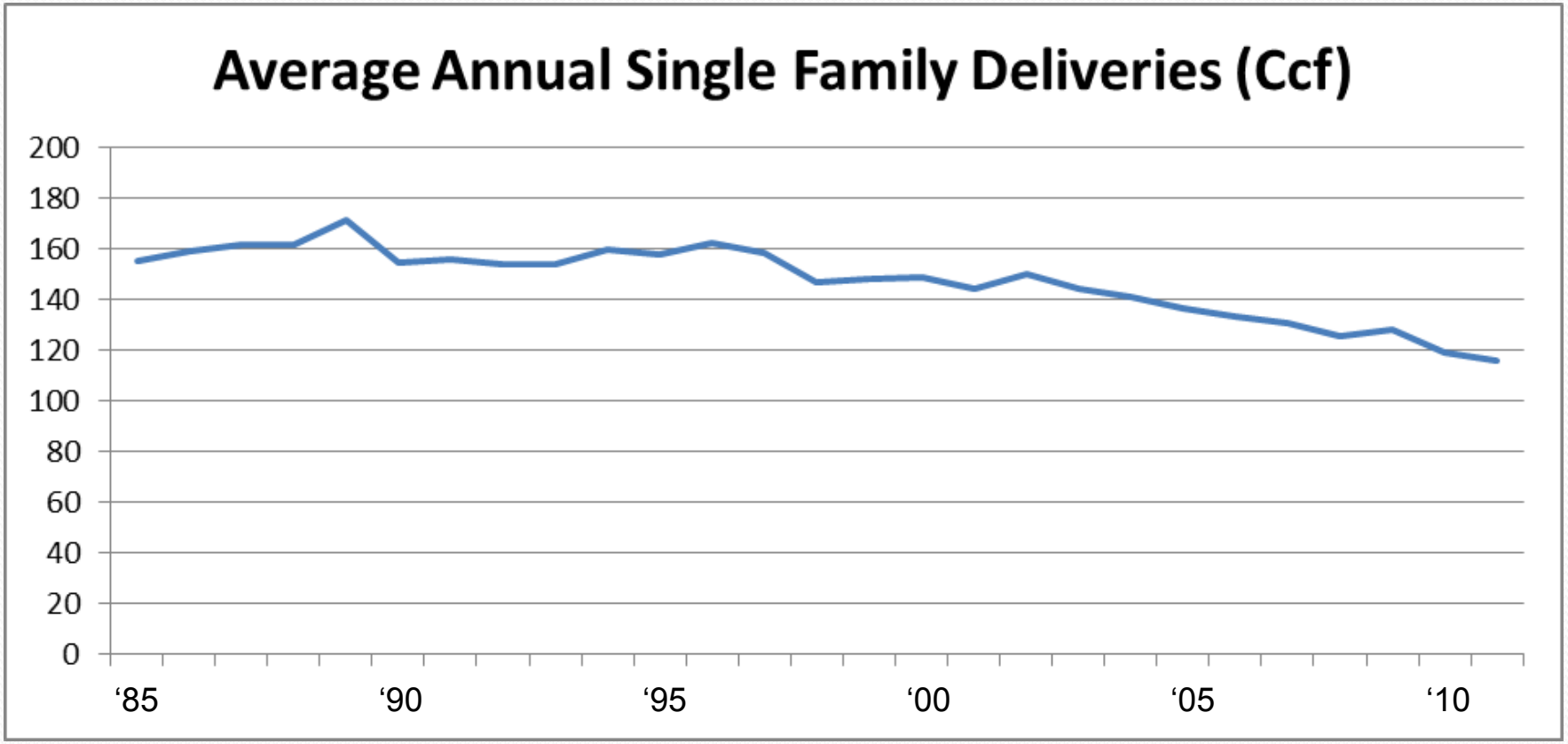
Short-term declines in per-capita water demand

Over the past 25+ years, municipal providers throughout the Southwest have experienced:

- Increasing service area populations and
- Growing numbers of residential customers, but
- Essentially flat water deliveries



Greater than 30% decrease for Tucson Water SFRs



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Other consequences include:

- an aversion to water conservation spending;
- a deeper interest in understanding long-term demand declines; and
- the need to improve ability to forecast future demand trends.

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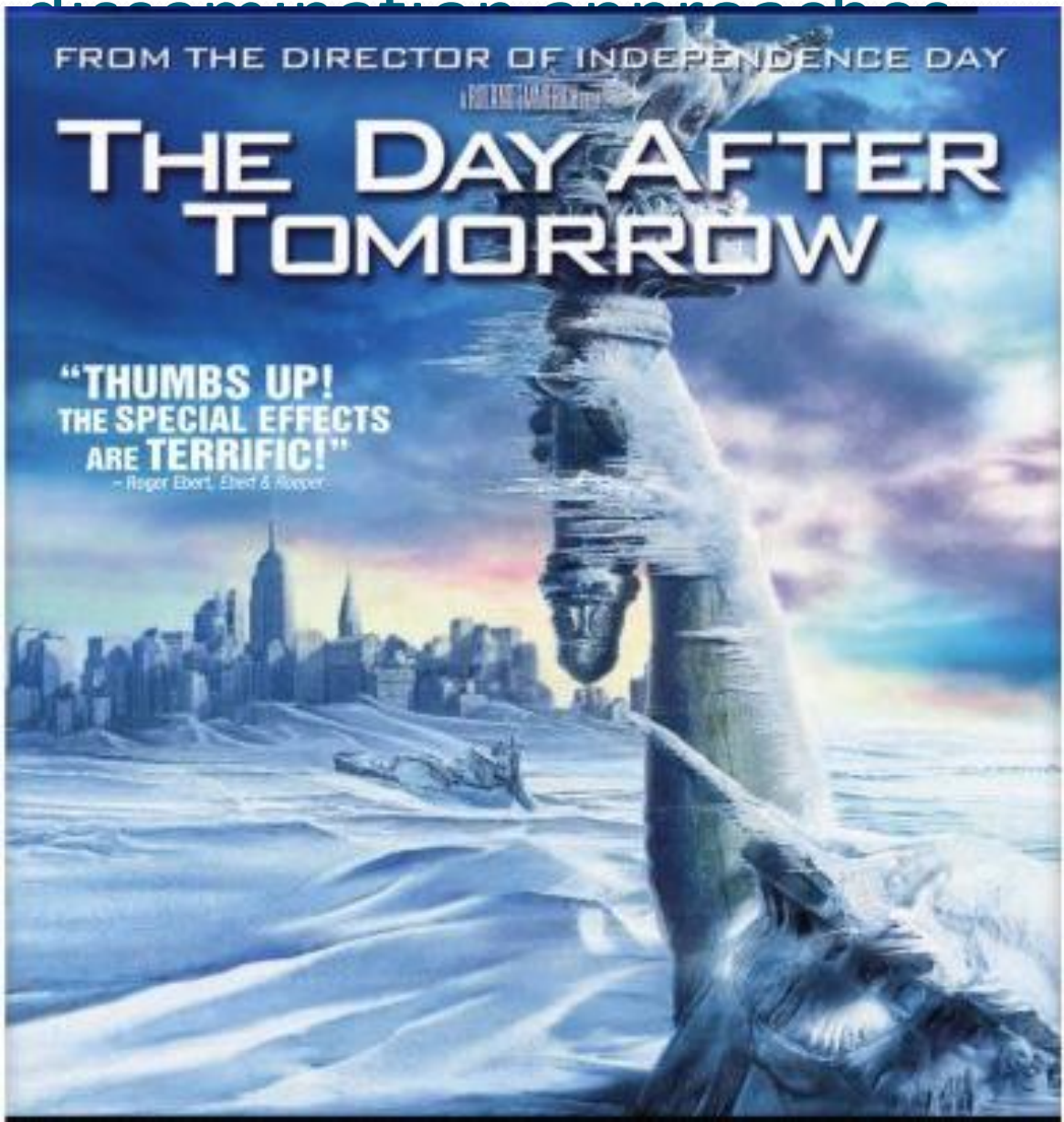
Research topics and methods

- Impact of new ULF toilet rebates
- Outdoor misting systems
- Problems with aging ULFs
- Water, gas, elec. rates & optimum landscapes
- Rate structure impacts
- Water reuse incidence
- Quality of harvested water
- Trends in housing stock
- Spatial characteristics of monsoon precipitation
- Time-series cross-sectional econometrics
- Test patio, physical modeling
- Micro-metering
- Models of houses, water and energy fluxes
- Detailed demand forecasts
- Survey
- Sampling, lab tests
- Analysis of appraiser data
- Citizen science program, RainLog.org

Non-traditional dissemination approaches

- Landscaping CD-RC
- Websites & web se
- Water harvesting d
- Water conservatio
- Ordinances, statut
- RainLog.org
- Smartphone apps
- Rate structures
- Movie premiere



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What is the value of water demand research?

A piece-meal, “academic” approach can have value if:

- You have a specific question (e.g., how effective is this conservation program; what is likely impact of new rates)
- The bigger picture is clear – you know where things stand overall, and how you got here

Today, most municipal water providers don’t know:

- Underlying causes of the long-term decline in gpcd
- Which impacts of the “great recession” are temporary
- What future housing construction will look like

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Aggregation of narrowly-focused studies won't answer these questions

$$Whole < \sum parts$$

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Possible factors of long-term decline:

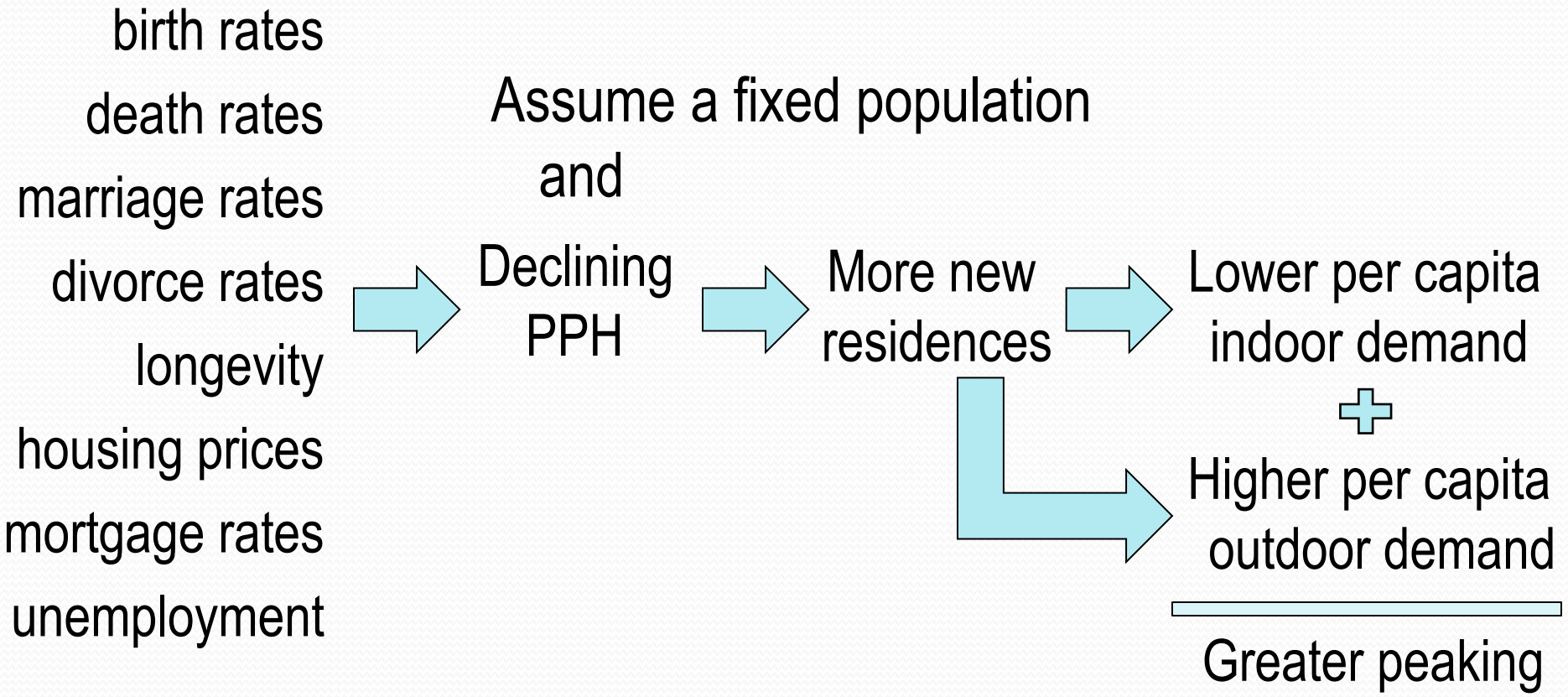
- water (and sewer) rate increases
- more effective water conservation programs
- declining household sizes (PPH)
- changing tastes in landscaping
- more water-efficient fixtures and appliances in new housing
- replacement of inefficient fixtures, appliances in older homes
- declines in popularity of backyard pools, use of pool covers
- shrinking lot sizes
- swamp coolers replaced by AC
- more seasonal residents

One way that PPH can decrease…

…and some alternative mechanisms:

- delayed age at first marriage
- more people never marrying
- declining birth rates
- more single-parent families
- increased longevity
- more affordable housing
- rising incomes

Barring alien abductions, what is the effect of decreasing pph on demand?



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PPH impacts water demand in complex ways

As PPH drops, the number of households increases; this results in a greater percentage of persons living in newer, more water-efficient homes.

This means:

- per capita indoor demand decreases
- per capita outdoor demand increases
- ratio of peak demand to average demand increases
- ability to respond to drought decreases

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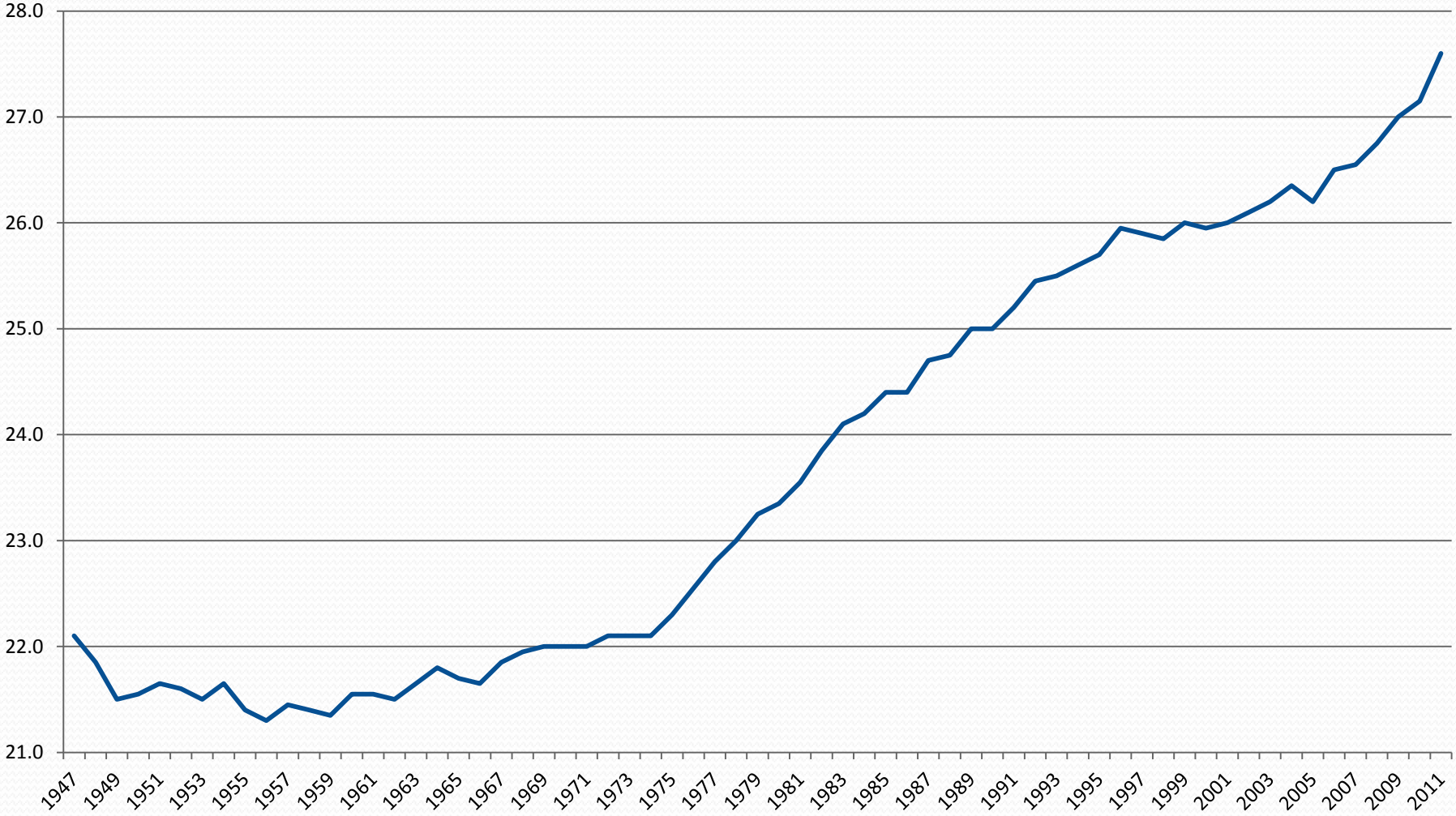
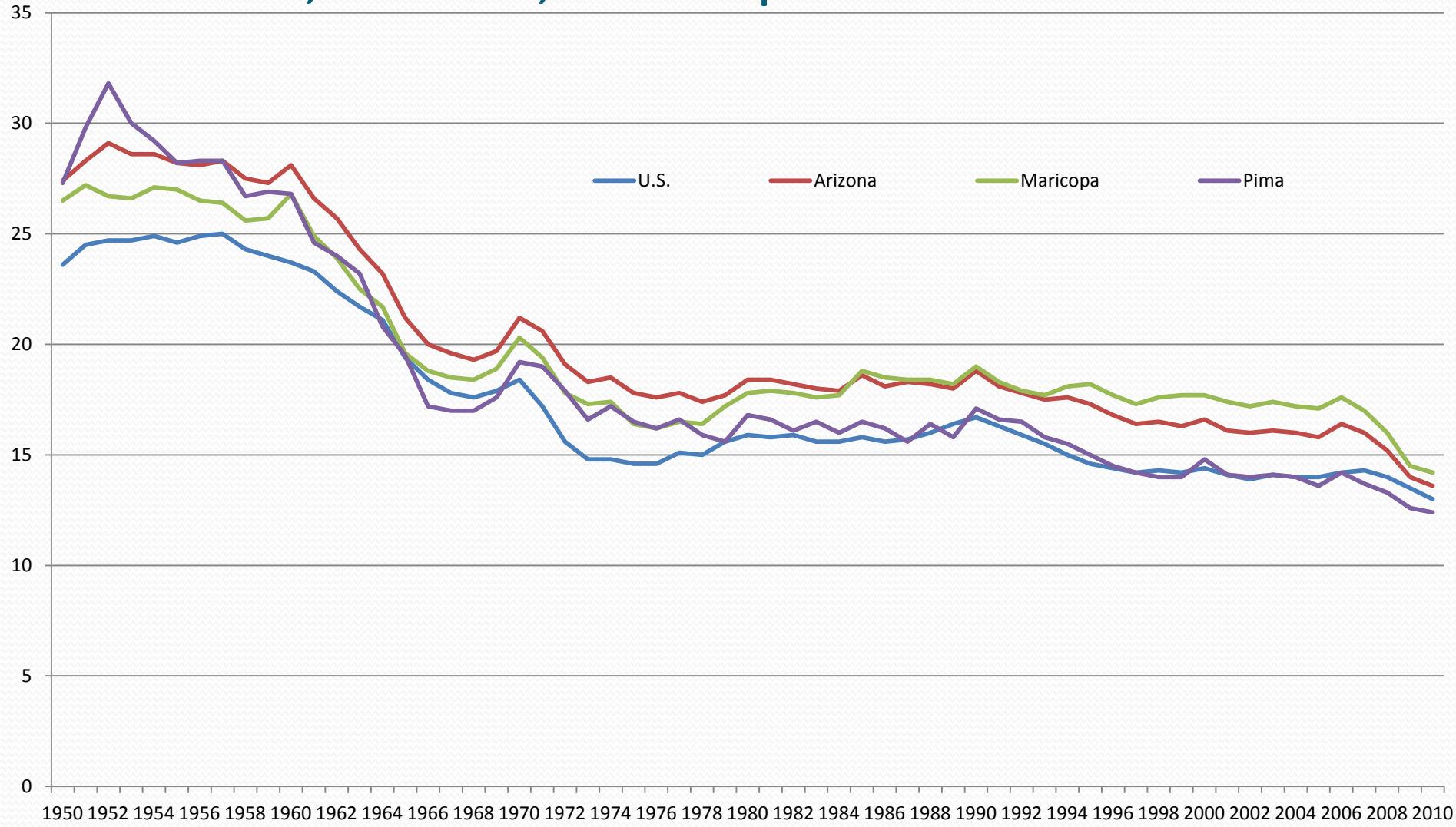
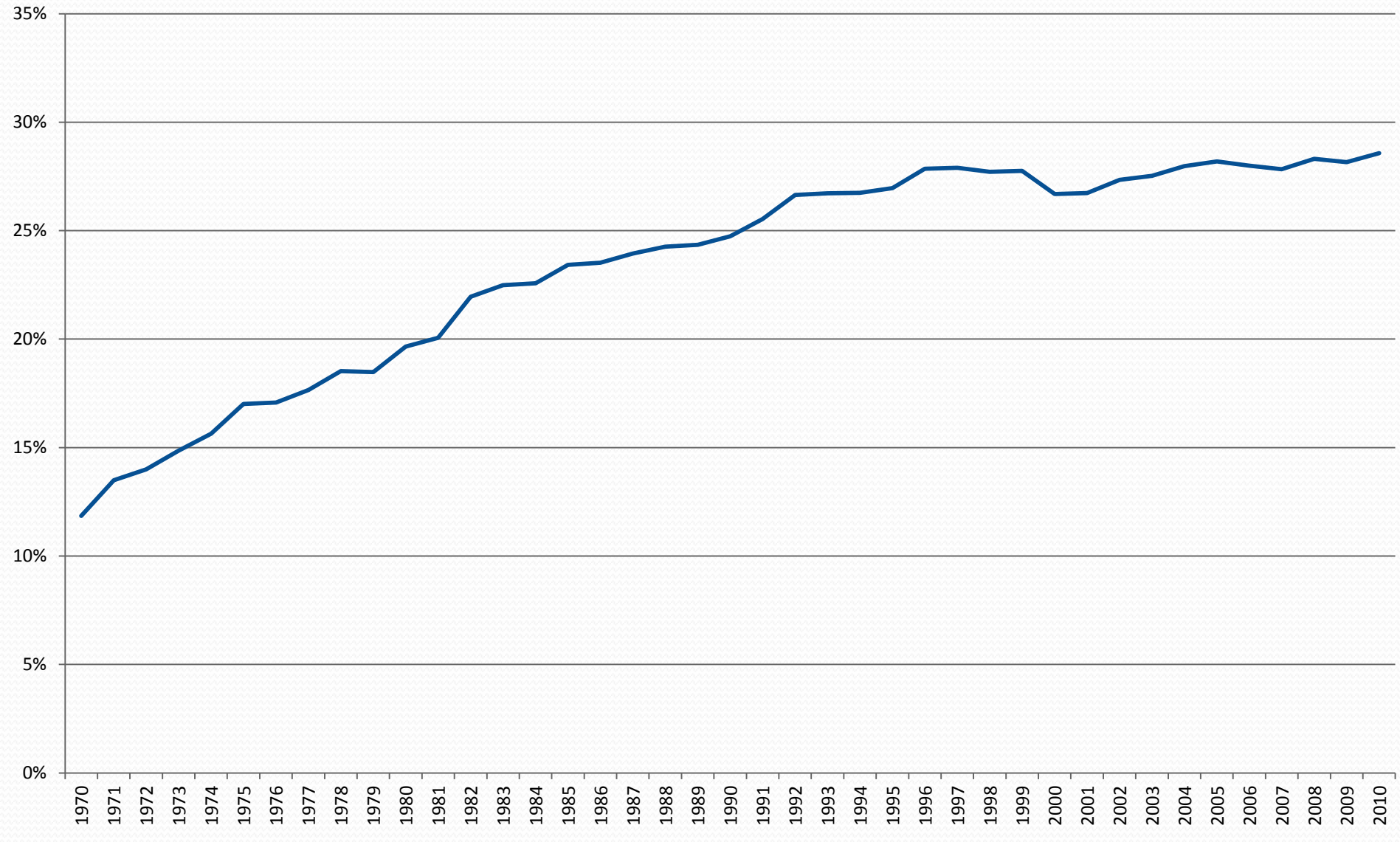
Trends in age at first marriage



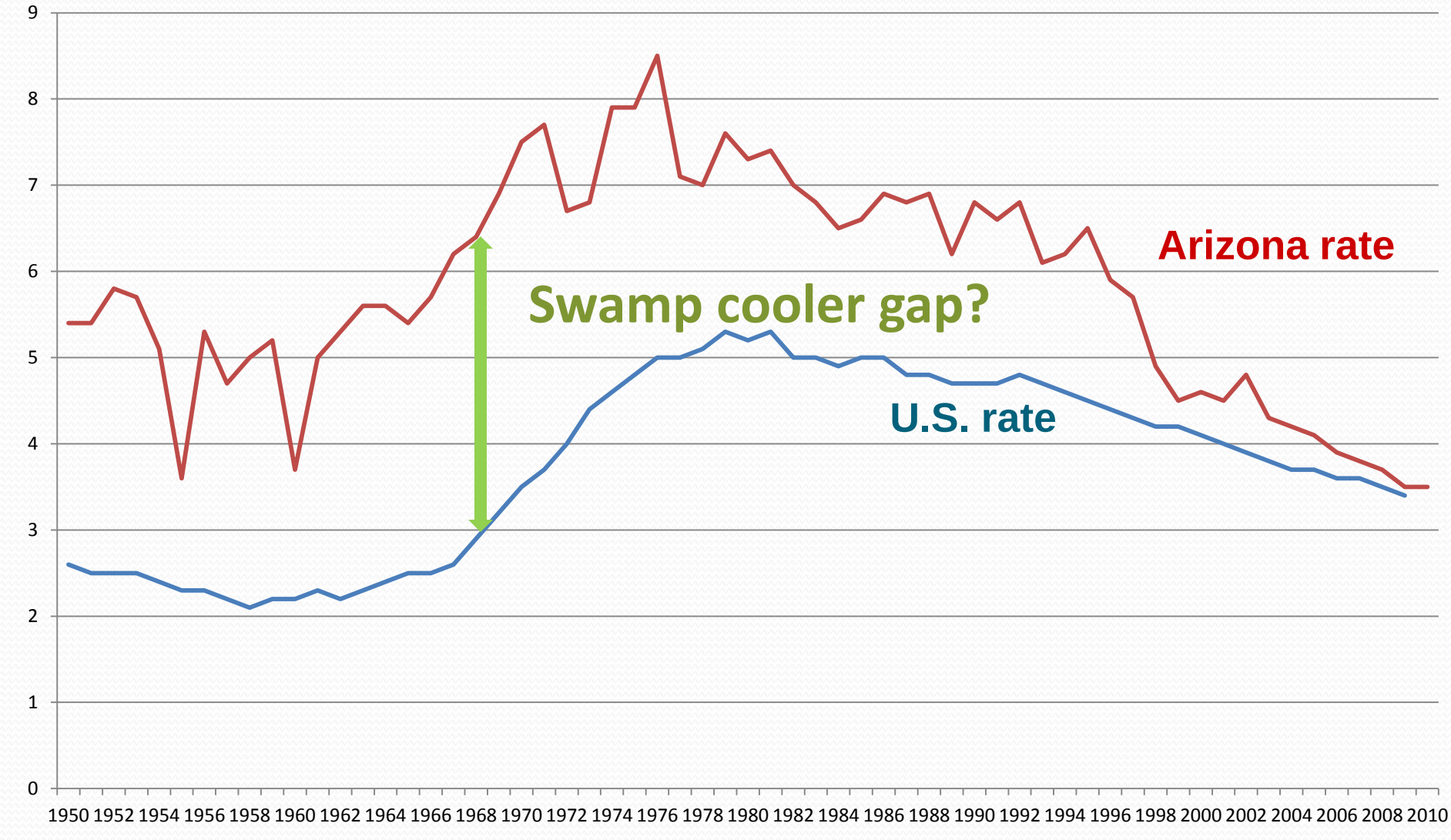
Trends in birth rates per 1,000 population for U.S., Arizona, Maricopa and Pima counties



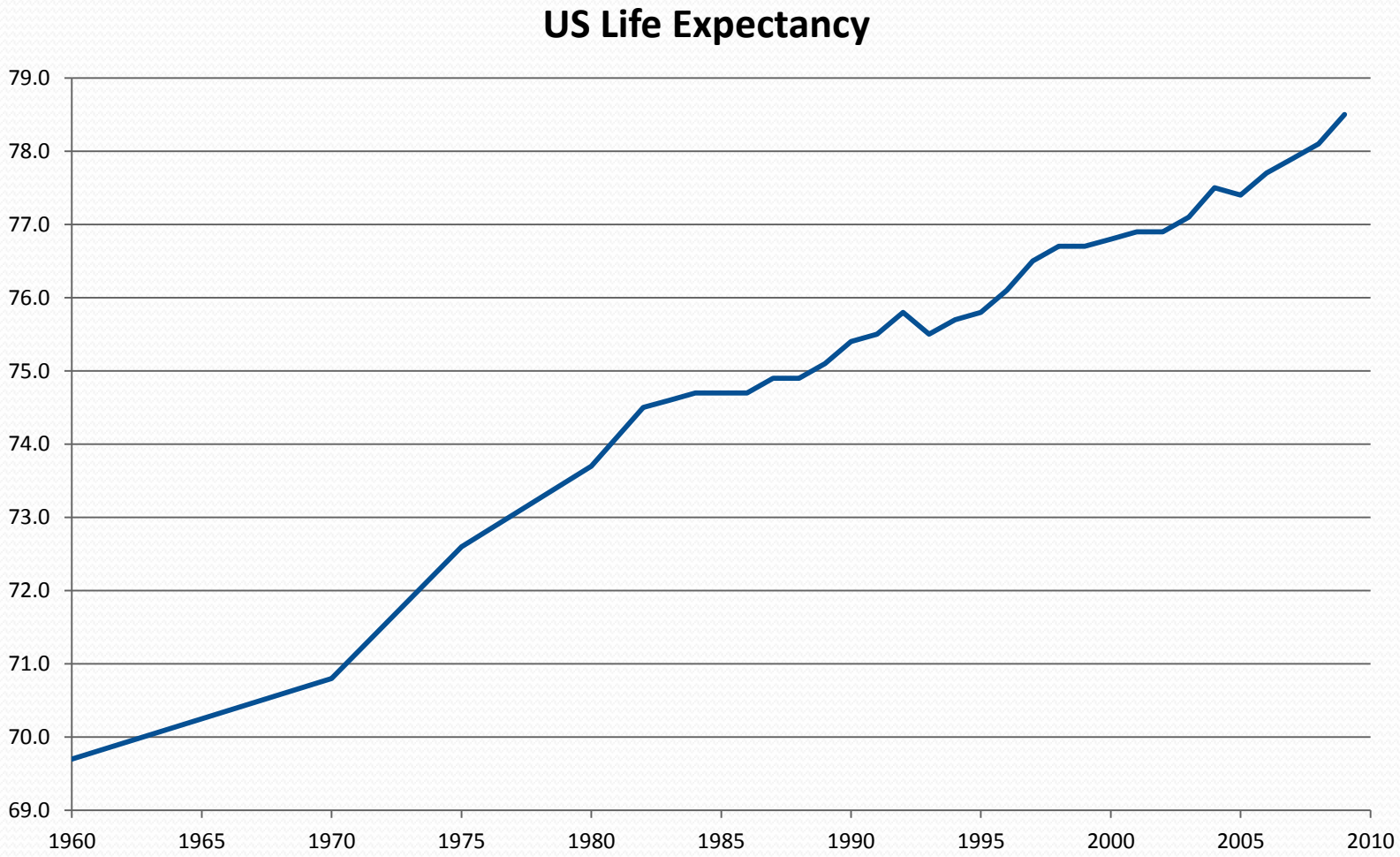
Trends in Single Parent Households



Trends in divorce rate



Trends in U.S. life expectancy



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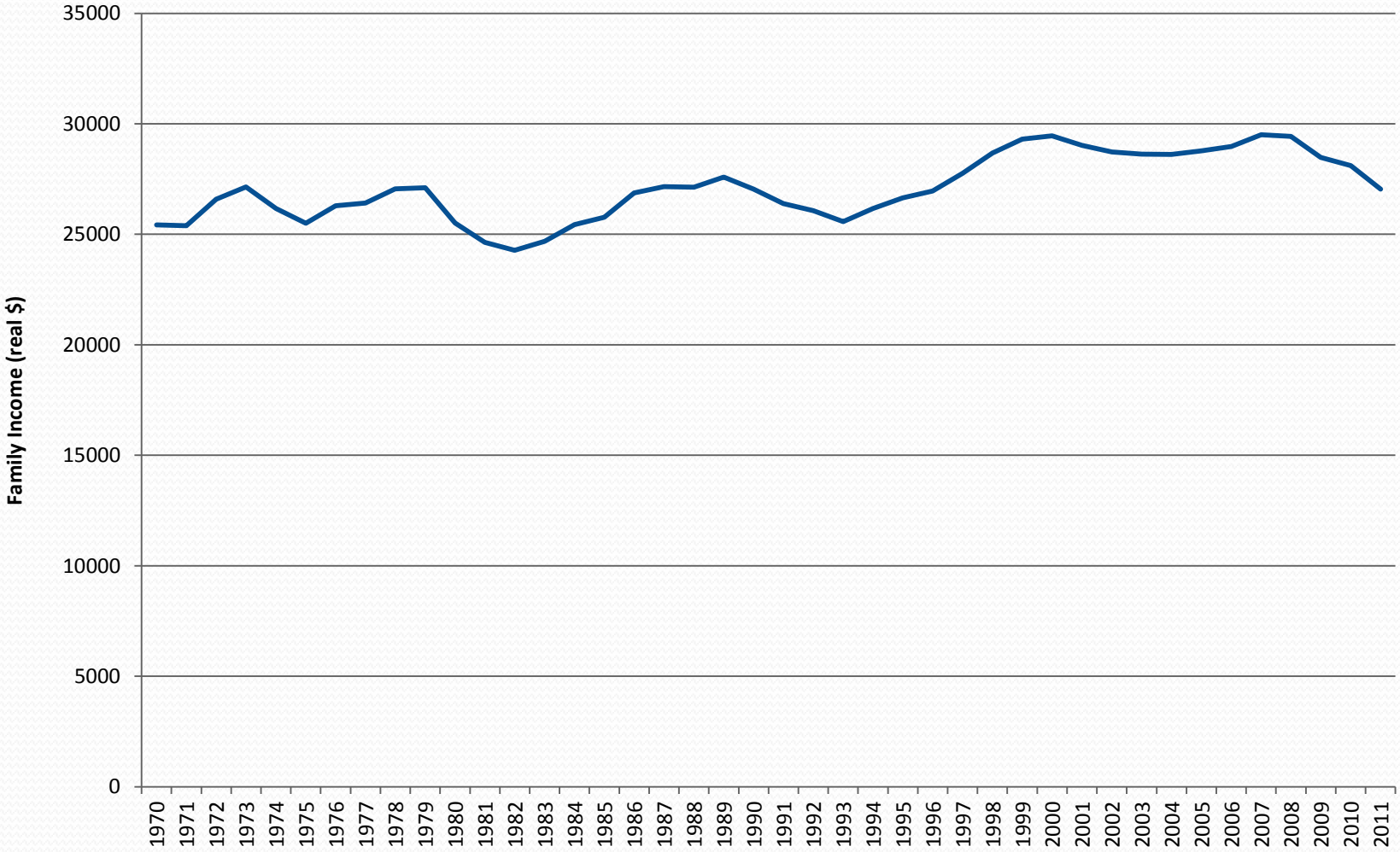
Family Income, real $, 1970-2011



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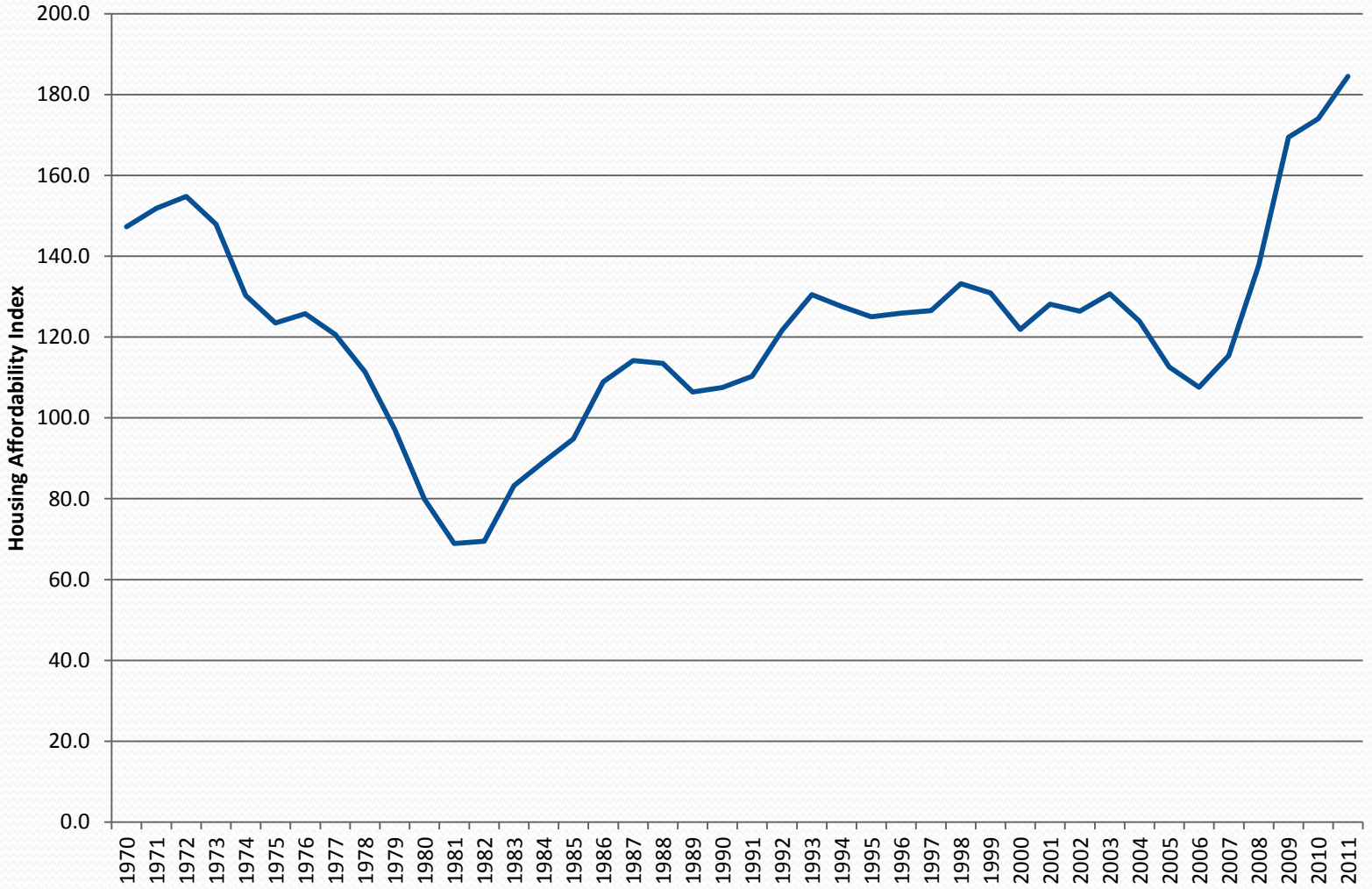
Source: National Association of Realtors

Housing affordability index, 1970-2011



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Source: National Association of Realtors

Possible factors of long-term decline:

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- replacement of inefficient fixtures, appliances in older homes
- declines in popularity of backyard pools, use of pool covers
- shrinking lot sizes
- swamp coolers replaced by AC
- more seasonal residents

Why shrinking lot sizes might not matter

- They haven’t shrank as much as some people perceive
- Shrinkage during housing boom linked to soaring land prices and “starter home” market
- Land prices have plummeted and the “starter home” market is all but gone
- Big shift from 1-story to 2-story houses reduces footprint
- Complex relationship between lot size, turf, and pools

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Lot size – turf – swimming pool

3 things that can increase outdoor water demand:

1. Larger lot size
2. Lusher landscaping, especially turf
3. Swimming pools

…but these factors cannot be considered in isolation.

If landscape is xeriscape or natural vegetation, larger lots do not use more water.

If landscape is dominated by turf, adding a pool may not increase water demand.

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In Richland Hts West, pools matter, but not lot size.

In Winterhaven, lot size matters, but not pools.

Proposed study's broad goals:

- Identify all plausible factors for long-term decline
- Gather all existing information on impact of factors
- Determine rate at which the incidence of these factors has been changing
- Identify "triggers" for changes in water-using factors
- Model and forecast future rates of change in existing housing stock
- Broadly describe future new housing characteristics, but will NOT forecast housing numbers or mix

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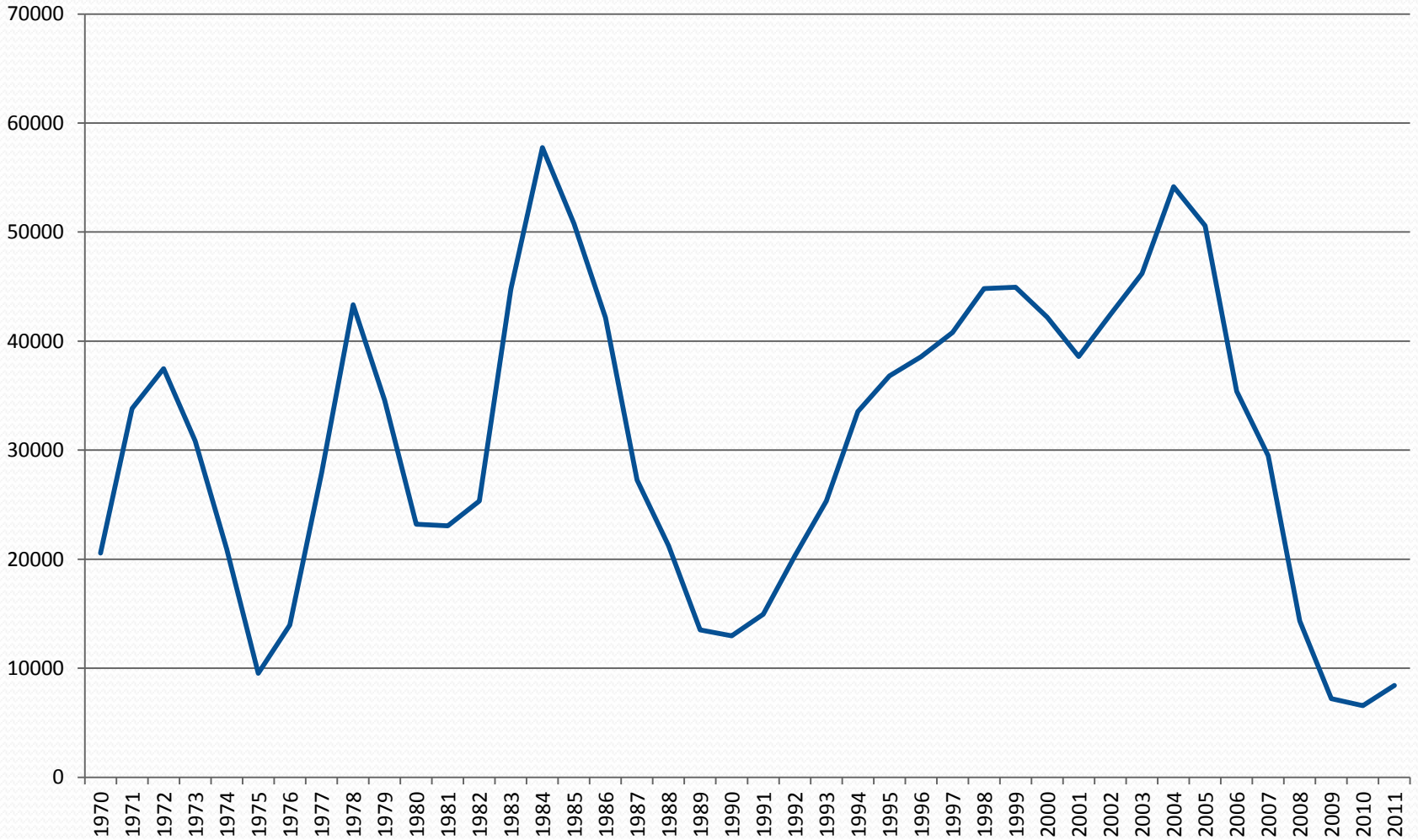
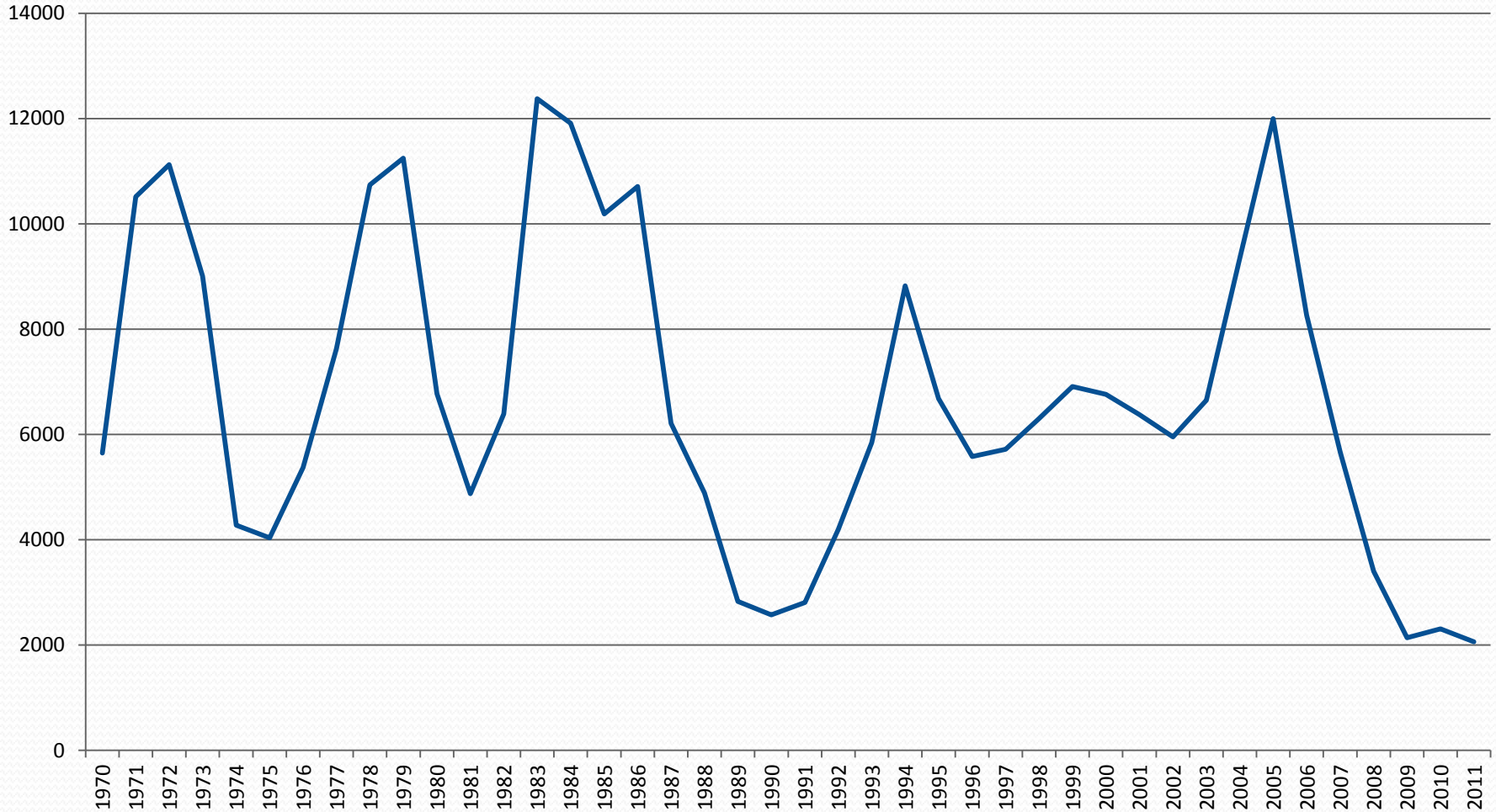
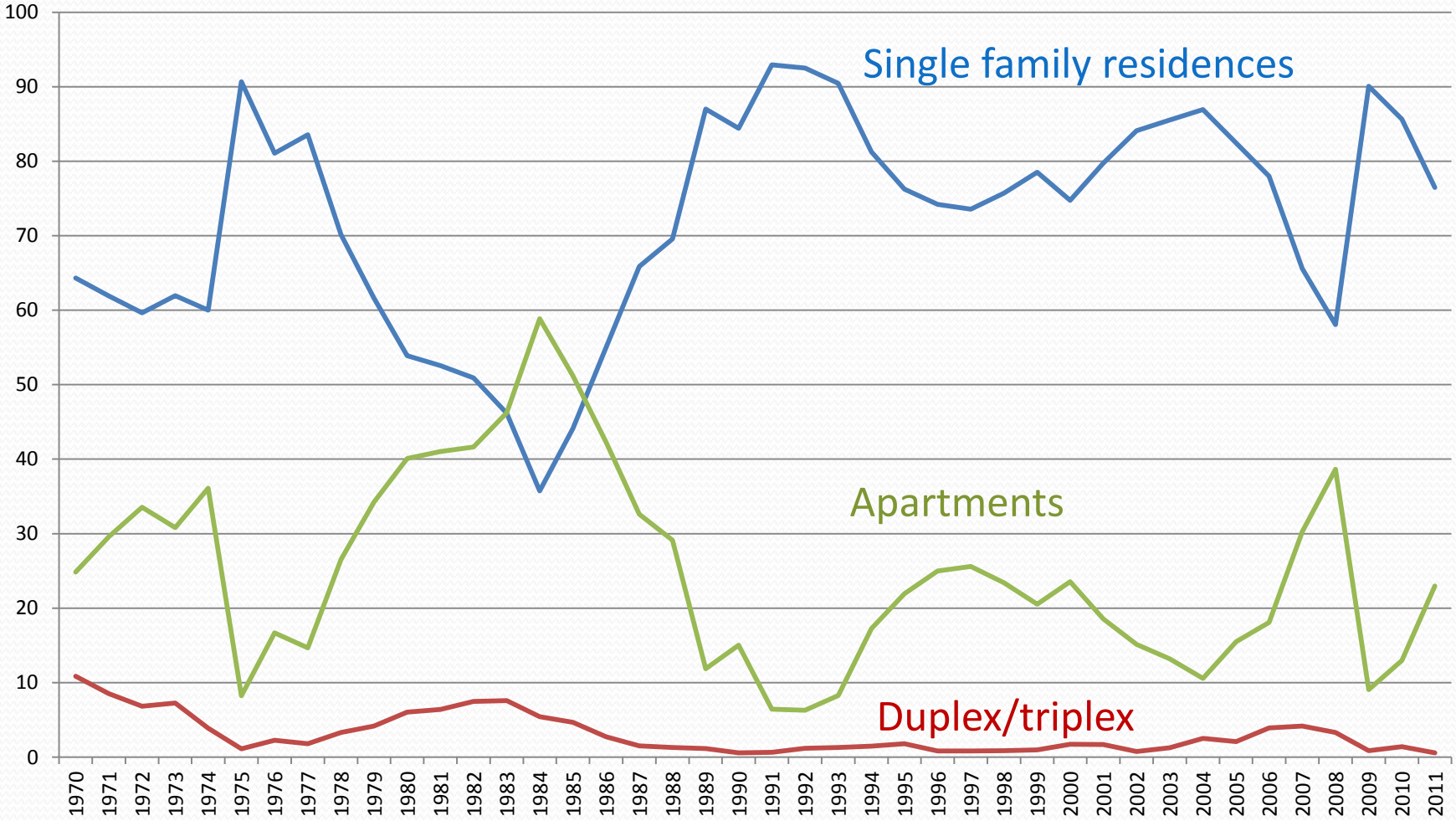
Construction of new housing, Maricopa County



Construction of new housing, Pima County



Composition of new housing, Maricopa County



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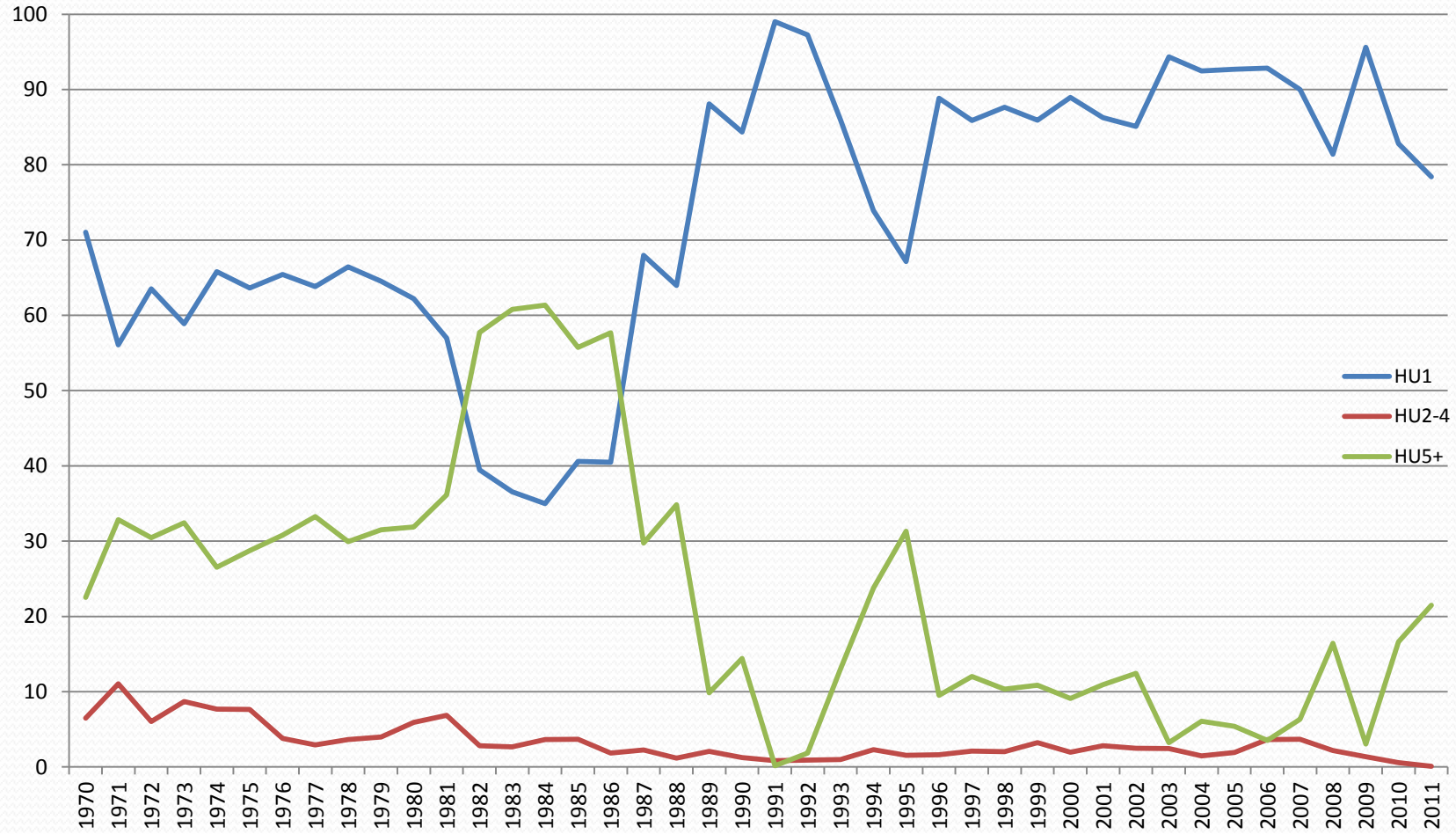

General approach

Disaggregate to manageable components (e.g., pool, turf, clothes washer)

Future water demand = future number or frequency x future water use rate

Future number or frequency = future state of current housing stock
+ state of new housing

Future state of current housing = current state + transitions

What triggers transitions?

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Transitions can be triggered by:

- new home owners
- switch between owner-occupied and rented
- major home renovation
- current water-using fixture or appliance breaks
- targeted conservation program, e.g., rebate
- having kids / empty nest syndrome
- contagion effect – the neighbors do something

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Transition triggers, cont.

- prolonged drought
- abrupt price change
- severe economic downturn
- major employer arrives or departs
- changes in tax policies
- marketing of new product, e.g., outdoor misting systems or horizontal axis clothes washers

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Factors Affecting Residential Water Demand

Housing Type

- Duplex/triplex
- Mobile home
- Single family detached
- Townhouse/condo
- Apartment

Residency

- Age of home
- Years lived in home
- Years lived in community

Monetary Factors

- Water/sewer rates
- Own or rent home?
- Value of home/monthly rent
- Annual income
- Pay the water bill?

Demographics

- Children under 5
- Children 5 to 18
- People home during day
- Head of household retired?

Appliances

- Vertical axis clothes washer?
- Dishwasher
- Garbage disposal
- Evaporative cooler/AC
- Installed low-flow device?

Landscape Factors

- Landscapable area
- Amount of turf
- How landscape is irrigated
- Swimming pool

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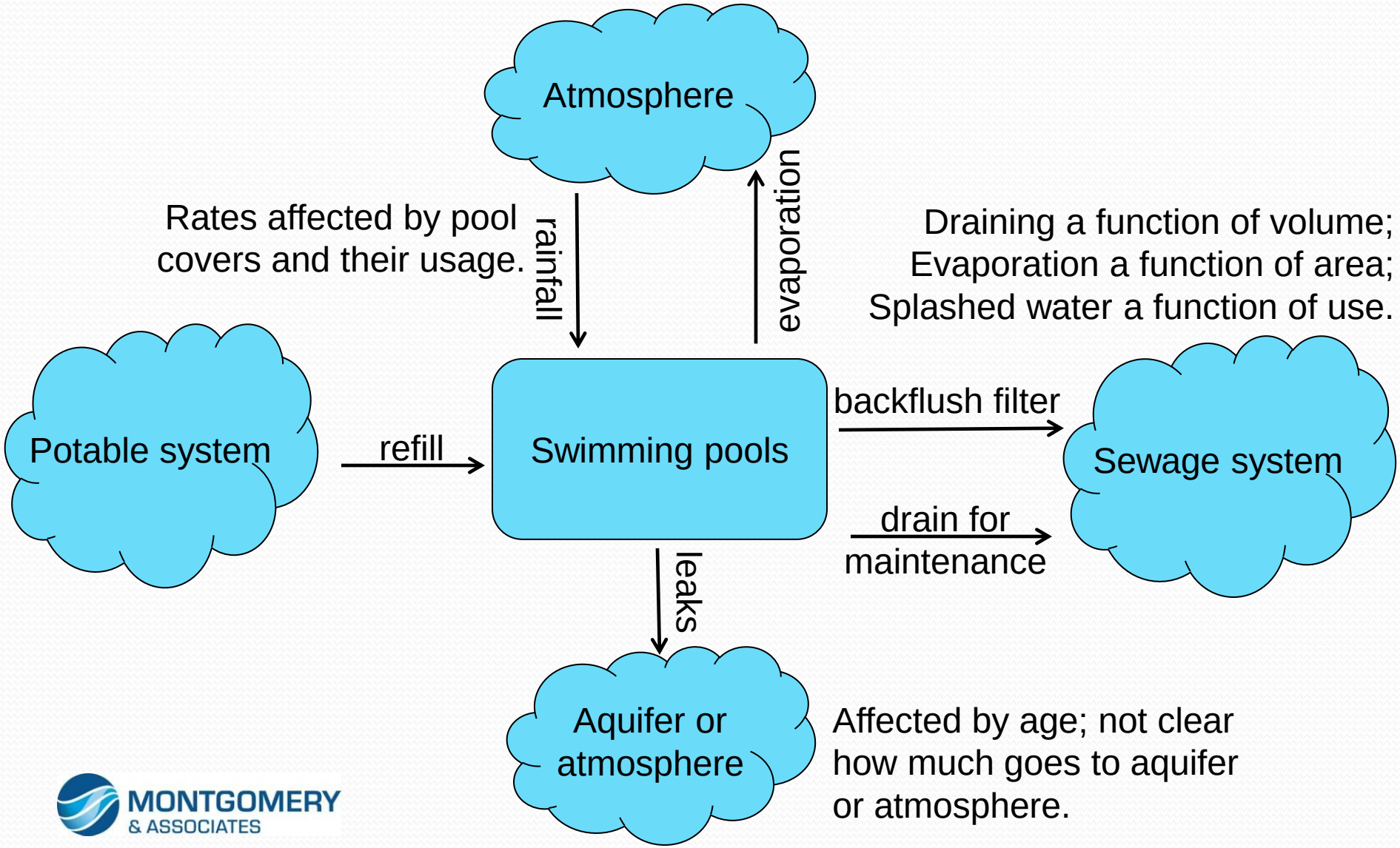
Home swimming pools & water demand impacts



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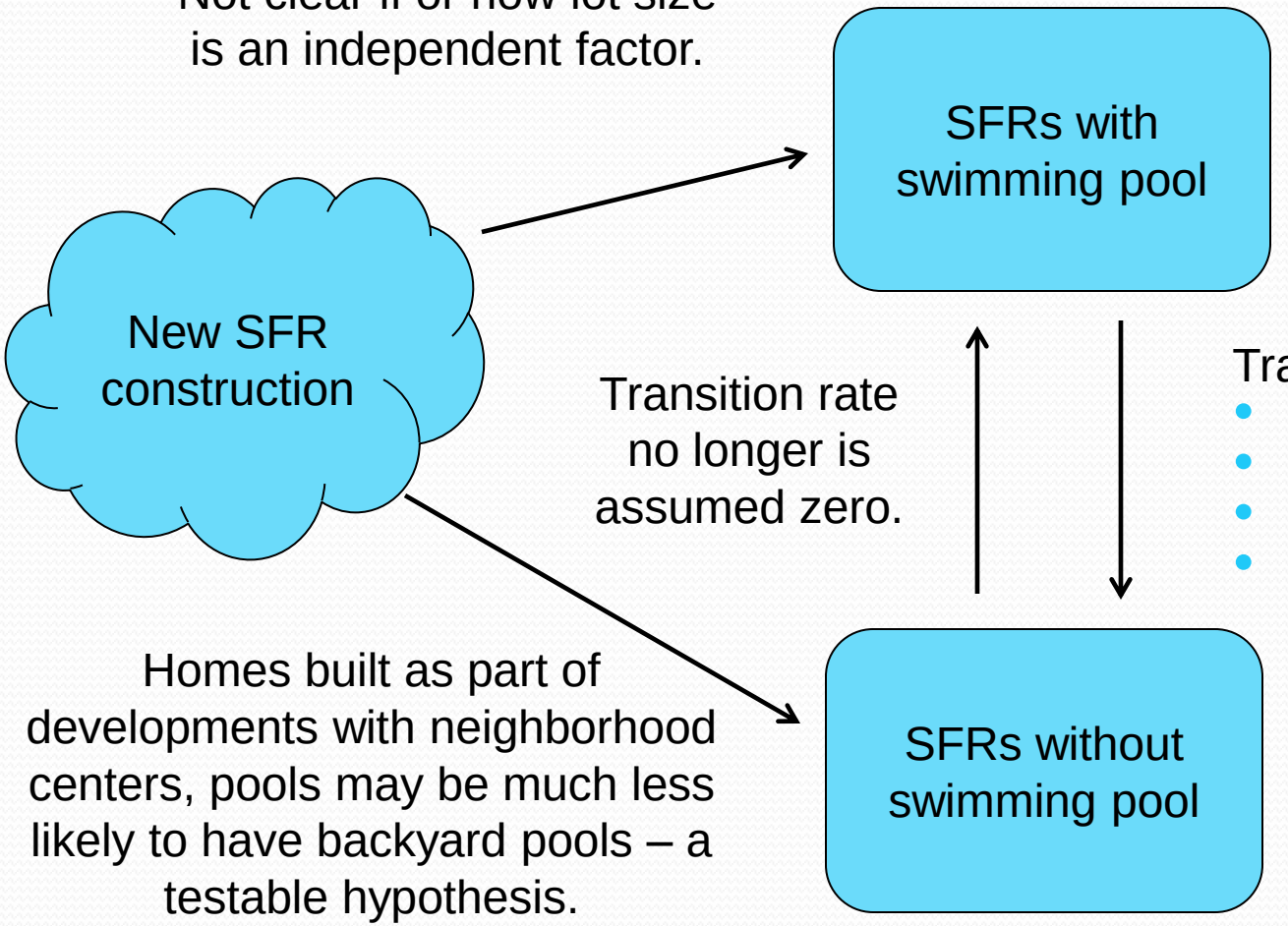
Home swimming pools and transition rates

Not clear if or how lot size is an independent factor.



Transition rate affected by:

- PPH, socio-demographics
- proximity to public pools
- new home owner
- home value, wealth

Homes built as part of developments with neighborhood centers, pools may be much less likely to have backyard pools – a testable hypothesis.

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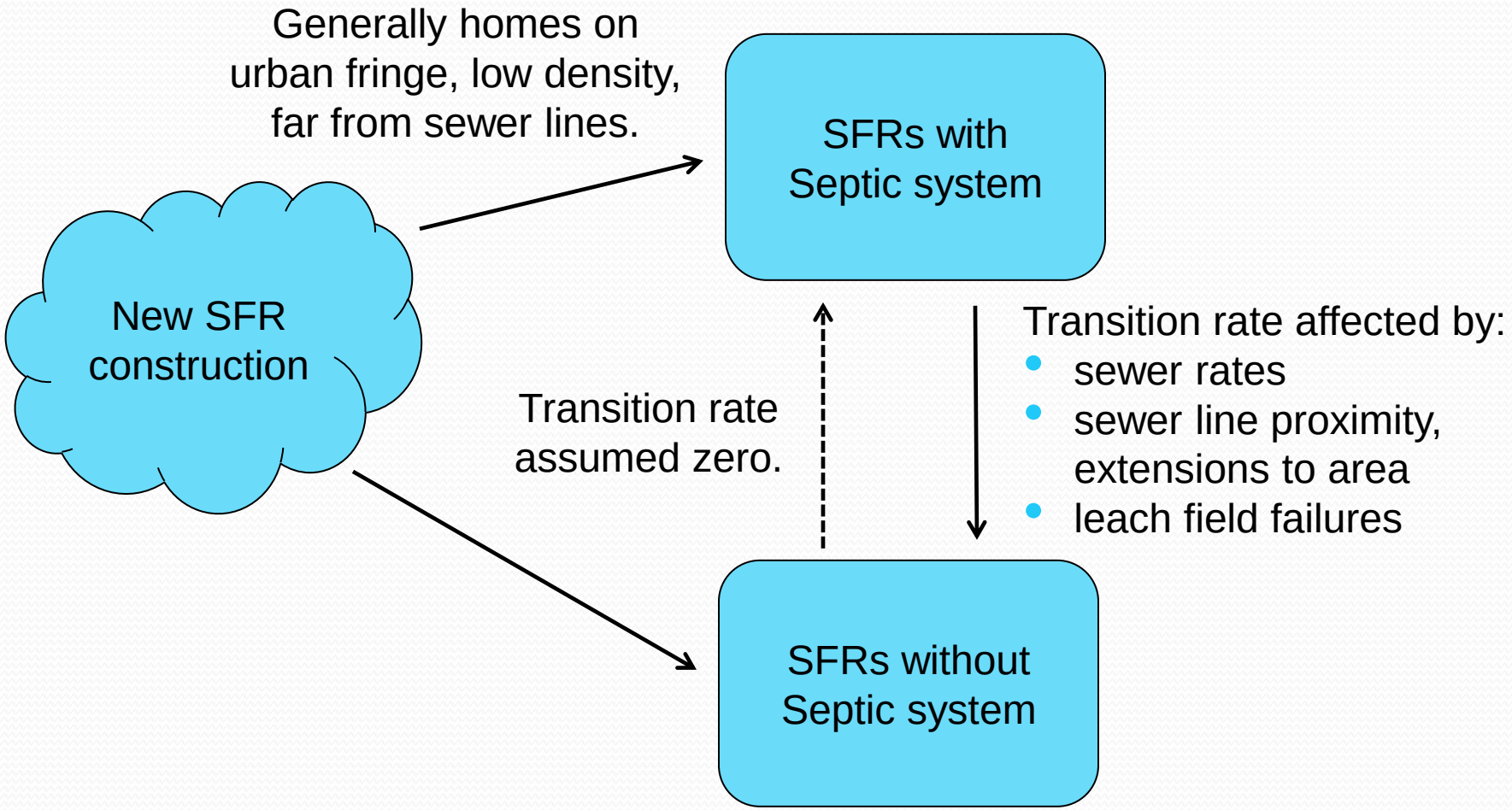
Home septic systems and transition rates



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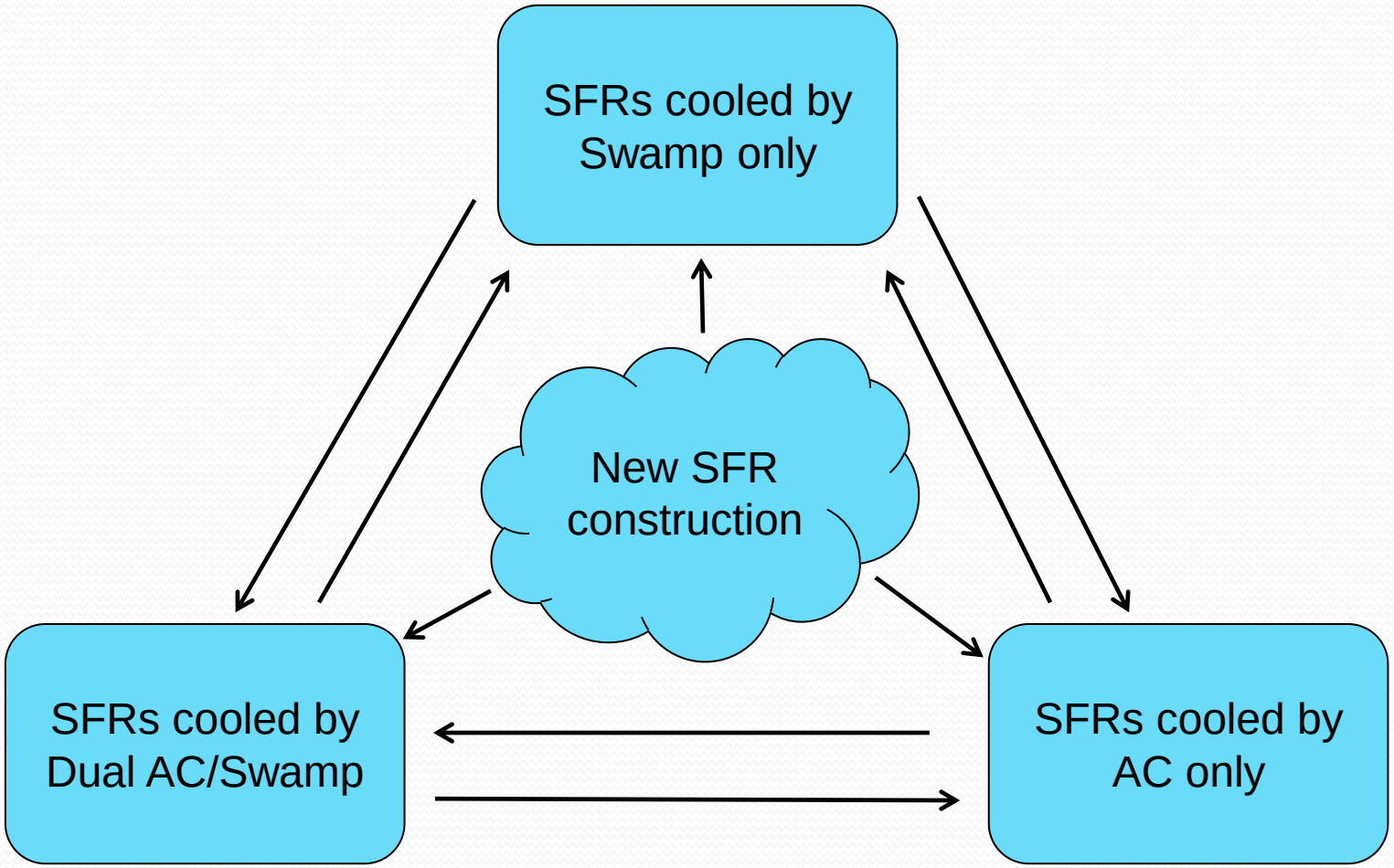
Home cooling options and transition rates



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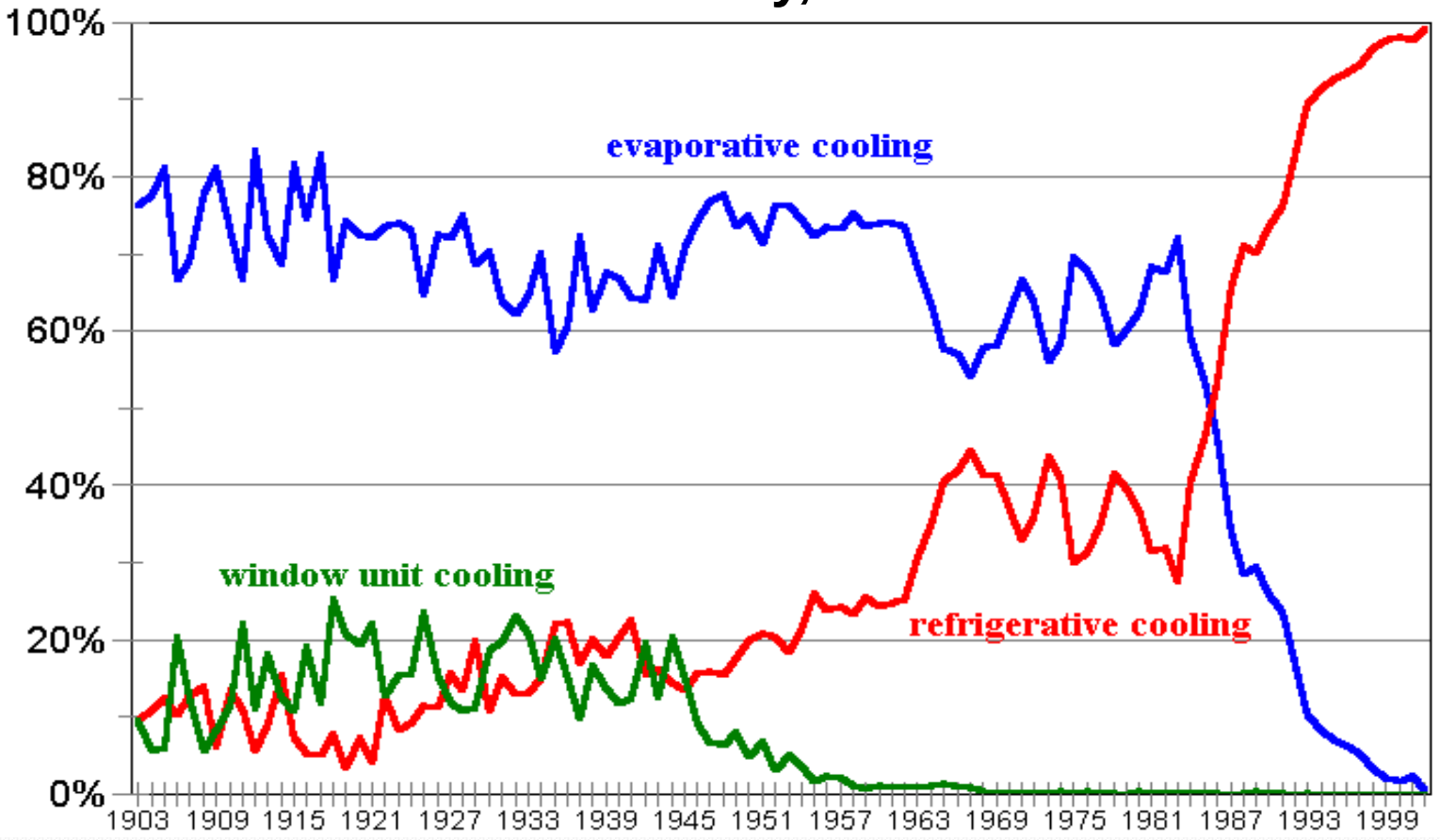
Evaporative cooling vs. refrigerative air conditioning

Home Cooling vs. Date of Construction
Pima County, 1903-2002



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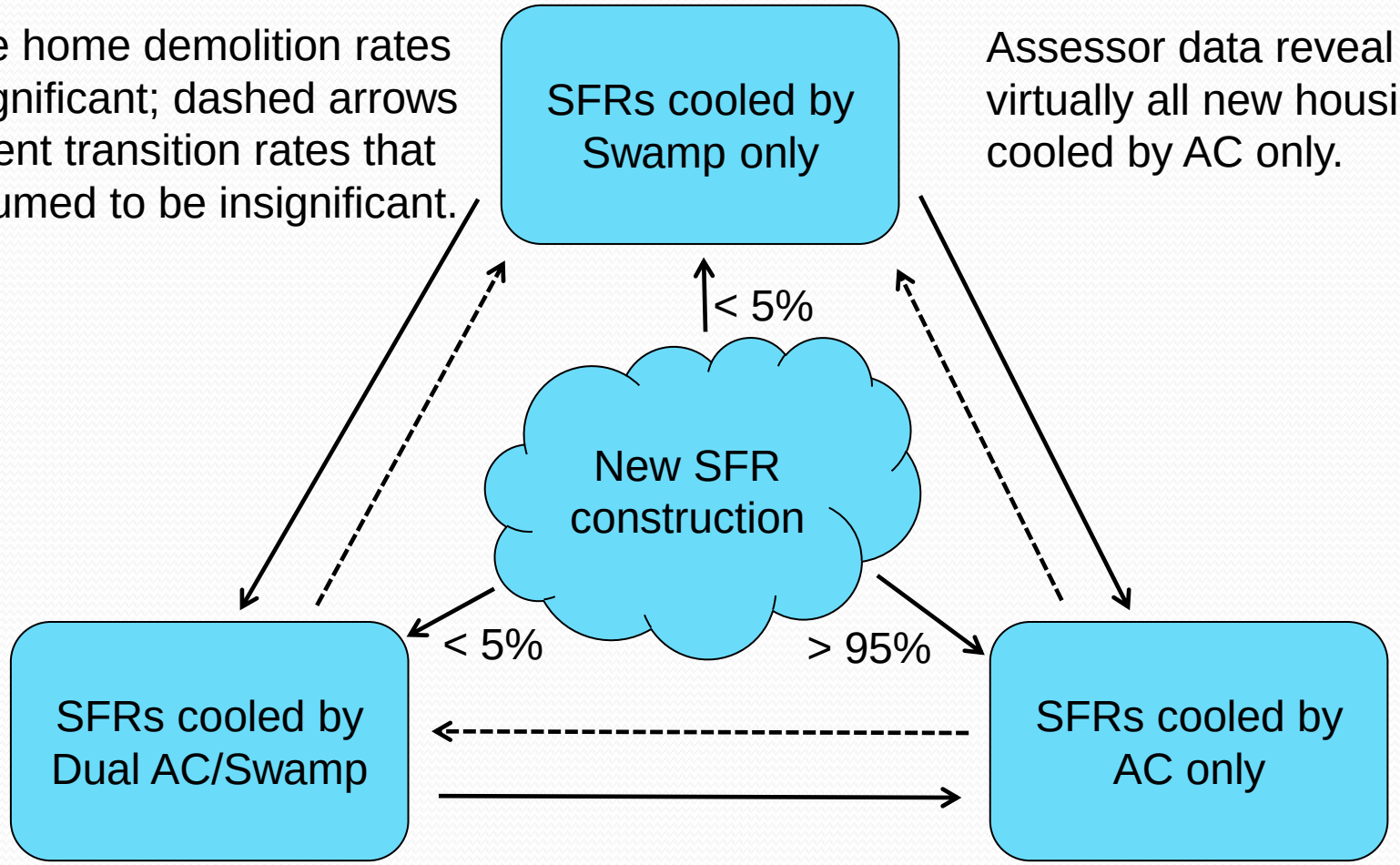
Home cooling options and transition rates

Assume home demolition rates are insignificant; dashed arrows represent transition rates that are assumed to be insignificant.

Assessor data reveal that virtually all new housing is cooled by AC only.



Transition rates for existing housing stock can be estimated by analyzing time series of assessor databases.

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Proposed study characteristics

- Don’t reinvent the wheel
- Make use of new, untapped data sources
- Use dynamic simulation modeling to integrate existing research results, forecasts, assumptions
- Use sensitivity analysis to pinpoint key unknowns
- Explore scenarios, don’t make static forecasts
- Create a whole that is greater than the sum of its parts

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Who I've spoken with…

- Tucson Water
- Mesa Water
- Phoenix Water
- Chandler Water
- Salt River Project
- CAP
- ADWR
- SAWUA
- BuRec

… and their major concerns

- How low could it go?
- Are some recession-caused drops in demand permanent?
- What will new housing look like in 3-5 years?
- Why the sharp drop in pools?
- What are CAGRD's unmet obligations?
- Is turf dead?

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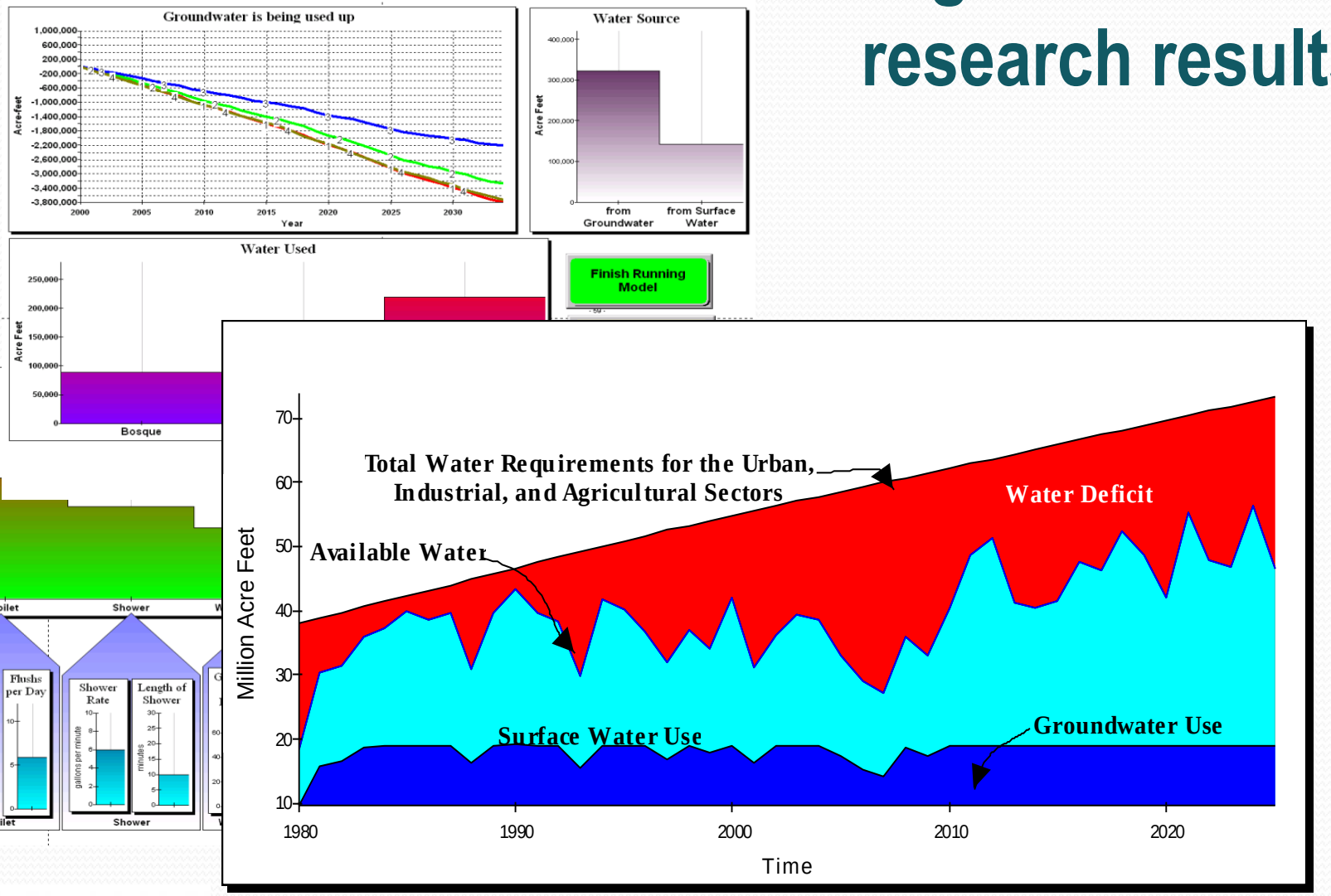
Dynamic simulation models integrate & clarify research results



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